

## An Automated Rover Command Generation Prototype for the Mars 2001 Marie Curie Rover

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Current rover sequence generation is manual, with limited ability to automatically generate valid rover activity sequences from more general activities/goals input by science and engineering team members. While tools such as the Web Interface for Telescience (WITS) and Rover Control Workstation, provide a smooth, natural way of specifying goals and activities, they do not provide feedback on resource usage, travel times, flight rule violations, etc. This current situation has two drawbacks. First, the science team cannot easily perform what-if analyses, and must specify actions rather than high-level science requests. This limits their control over the final rover activities – resulting in reduced science. Second, the engineering team must manually construct and validate sequences, creating a tremendous workload. Manually changing rover activities on the same day as execution is very difficult due to long round-trip communication times for interplanetary missions. Additionally, it will be challenging to extend this manual process to longer duration missions such as the NASA Mars 2001 rover, Marie Curie.

This paper will discuss a proof-of-concept prototype for automatic generation of validated rover command sequences from high-level science and engineering activities. This prototype is based on ASPEN, the Automated Scheduling and Planning Environment. This AI-based planning and scheduling system will automatically generate a command sequence that will execute within resource constraints and satisfy flight rules. Commanding the rover to achieve mission goals requires significant knowledge of the rover design, access to the low-level rover command set, and an understanding of the performance metrics rating the desirability of alternative sequences. It also requires coordination with external events such as orbiter passes and day/night cycles. An automated planning and scheduling system encodes this knowledge and uses search and reasoning techniques to automatically generate low-level command sequences while respecting rover operability constraints, science and engineering preferences, and also adhering to hard temporal constraints. Enabling goal-driven commanding of planetary rovers by engineering and science personnel greatly reduces the requirements for highly-skilled rover engineering cognizant personnel and Rover Science Team time. This in turn greatly reduces mission operations costs. In addition, goal-driven commanding permits a faster response to changes in rover state (e.g., faults) or science discoveries by removing the time consuming manual sequence validation process, allowing rapid what-if analyses, and thus reducing overall cycle times.